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Innovation and Skill Upgrading: The Role of External vs Internal Labour Markets[♣]

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Abstract

Following technical and organisational changes, firms may react to increasing skill requirements either by training or hiring the new skills, or a combination of the two. Using matched datasets with about 1,000 French plants, we assess the relative importance of these external and internal labour market strategies. We show that skill upgrading following technological and organisational changes takes place mostly through internal labour markets adjustments. Consistently with the results in the literature, we find that new technologies and organisational changes are associated with an upward shift in the occupational structure within firms. We show that about one third of the upgrading of the occupational structure is due to hiring and firing workers on the external labour market, whereas two-thirds are due to promotions. Moreover, we find no compelling evidence of external labour market strategies based on "excess turnover". In contrast, French firms heavily rely on training in order to upgrade the skill level of their workforce. When splitting the sample across sectors, this pattern of results appears to be particularly strong for manufacturing firms whereas, in services, external labour market strategies tend to be more widespread. We then consider the determinants of the strategies chosen by firms. We argue that the relative cost of internal versus external labour market flexibility is likely to be critical and that it can be partly captured by firm size and by the density on the local labour market. We find that external labor market strategies tend to be more important when firms are located on high-density labor markets.

Keywords: Technical and organisational change; turnover; skill bias; training; internal labour markets.

JEL codes: J23; J24; J41.

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Introduction

Explaining the rise in wage inequalities has been high up on the research agenda of labour economists over the past two decades. Skill-biased technical change has emerged as a part of the explanation. In its simplest version, the story runs as follows: confronted with the falling price of computers and a relatively abundant supply of skilled labour, firms have adopted skilled-biased technologies, i.e. information-based technologies that substitute workers in routine tasks and complement workers in analytical and interactive tasks (Autor, Levy and Murnane, 2003; Spitz-Oener, 2006). This has increased the demand for skilled workers on the labour market, generating in turn a rise in the relative wage of highly educated workers despite the rising skill supply (see Chennells and Van Reenen, 2002, for a review). The adoption of innovative workplace practices induced by the development of new technologies had very similar effects and further increased the relative demand for skilled labour (see Caroli and Van Reenen, 2001; Bresnahan et al., 2002 and Walkowiak, 2006).

This simple story of skill-biased technical/organisational changes and (external) labour market equilibrium does not consider the role possibly played by *internal* labour markets, i.e. the way long-term relationships between the firms and their workers have evolved in relation with the adoption of new technologies and innovative work practices. However, this question is of particular relevance given the attention paid in recent years to potential changes in employment relations. Atkinson (1999) suggests that long-term employer-employee relationships have declined and, correspondingly, the perception of job insecurity has increased in most OECD countries in the 1990s (OECD, 2003). However, existing empirical evidence on rising job instability and the decline of internal labour markets is actually quite mixed[1]. A few recent papers have investigated how employment relations may have been affected by technological and organisational changes. They also provide contrasted evidence.

A first strand of literature suggests that skill-biased technical change has contributed to a decline of internal labour markets. Givord and Maurin (2004) find that the use of new technologies increases the annual transition rate from employment to unemployment, and that this is enough to explain the global trend toward greater job insecurity observed in France. Consistently, Di Prete et al (2002) find that returns to tenure are lower in high-tech industries in the USA, suggesting that the "freshness" of workers has become more valuable than their

[1] See Neumark, Polsky and Hansen 1999; Gottschak and Moffitt 1999; Behaghel, 2003; Stevens (2005) and Farber (2007a, 2007b).

experience in innovative firms. Cappelli and Neumark (2004) find more mixed results with new work practices being positively associated with external churning only in non-manufacturing sectors. Looking at worker flows by skill levels in France, Askenazy and Moreno-Galbis (2007) find that ICT adoption is positively correlated with a higher turnover of clerks and manual workers whereas new organisational practices are positively correlated with a higher turnover of managers. For Germany, Bauer and Bender (2004) find that firms that introduce organisational changes have significantly higher job destruction and separation rates for the lowest skilled workers so that organisational change appears to be skill-biased. Moreover, they find that adjustments of the workforce following changes in workplace organisation mostly rely on external worker flows with the effect of internal flows being negligible. All these results suggest that firms meet the new skill requirements following the introduction of innovative workplace practices through adjustments on the external rather than internal labour market.

However, another strand of literature suggests that the adoption of information technologies and innovative workplace practices also raises firms' investment in training, which is a typical internal labour market response. On US data, Lynch and Black (1998) find that the proportion of workers receiving formal training is higher in firms that use high performance work practices such as Total Quality Management, benchmarking or self-managed teams. Zamora (2006) finds similar results for France using a first-difference specification: the introduction of new work practices increases the proportion of trained workers, especially for blue-collars and middle-managers, both in the short and medium run. In contrast, the impact of technological changes on training is significant only in the short run, while fading away in the longer run. Behaghel and Greenan (2005) use matched employer-employee data for France and also find that a more innovative organisation increases the probability that workers receive training.

As underlined by this review of the literature, most works consider only one type of labour market response to technological and organisational innovations. They either study internal or external labour market strategies, but rarely both at the same time. However, as suggested by Mincer (1989), these strategies are likely to be correlated with each other. Firms may react to increasing skill requirements either by combining in some way training with the hiring of new skills or they may, on the contrary, rely on one strategy at the expense of the other. The characteristics of this choice and its determinants are the focus of the present paper.

Using French data, we first show that, consistently with the results in the skill-bias literature, the adoption of new technologies and organisational changes is associated with an upward shift in the occupational structure within firms. We then investigate to what extent this shift may be ascribed to external rather than internal movements of the workforce. We show that about one third of the upgrading of the occupational structure is due to hiring and firing workers on the external labour market, whereas two-thirds are due to promotions. This suggests that adjustments on the internal labour market still play an important role in coping with increasing skill requirements. However, the distinction between skill upgrading through entries and exits and promotions may not capture all possible forms of external and internal labour market adjustments. External adjustments may also take the form of "excess turnover" – i.e. turnover in excess to what is necessary to upgrade the occupational structure - if firms try to acquire new skills by the adjunction of "fresh" workers. In contrast, they may train their own workers thus relying on the internal labour market. We find no compelling evidence of external labour market strategies based on "excess turnover". In contrast, French firms heavily rely on training in order to upgrade the skill level of their workforce. When splitting the sample across sectors, this pattern of results appears to be particularly strong for manufacturing firms whereas, in services, external labour market strategies tend to be more widespread.

We then investigate the determinants of the strategies chosen by firms. Choosing between external and internal labour market adjustments is likely to depend on the relative cost of both strategies. So, one may expect small firms to rely more on external labour market adjustments, due to the lack of workers with the required characteristics for promotion and/or training available within the firm. Similarly, firms located in areas where the labour market is dense can be expected to rely more on external adjustments than firms in low-density areas, because of the higher probability of finding workers with the right skills outside the firm. Our results suggest that firm's size does not make much of a difference in terms of external versus internal labour market strategies. In contrast, firms mostly rely on training in low-density areas whereas external labour market adjustments are much more frequent in high-density zones.

The paper is organised as follows. Section 1 outlines the econometric model. Section 2 presents the data. The results are presented in Section 3 and some discussion and concluding remarks are offered in Section 4.

1. The Econometric model

We build upon existing empirical models of skill biased technical/organisational change to develop a system of equations that describes how firms rely upon internal and external labour markets when they implement technical and organisational changes. This section describes the overall approach and the estimation method used.

Skill biased technical and organisational changes

Theoretical models of skill biased technical/organisational change predict a positive correlation (all other things kept equal) between the use of more advanced technologies and/or workplace practices and the skill level of the workforce. A very simple test would rely on the following regression:

$$SKILL_i = z_i\beta + TECH_i\delta + ORGA_i\gamma + \varepsilon_i \quad (1)$$

where *TECH* and *ORGA* are technology and organisation measures, *SKILL* is a measure of the workforce's skills, and *z* are control variables. One would then test whether δ and γ are positive.

Taking first differences in order to get rid of unobserved heterogeneity in the variables in levels yields the following specification, most common in the literature:

$$\Delta SKILL_i = x_i\beta + \Delta TECH_i\delta + \Delta ORGA_i\gamma + \upsilon_i \quad (2)$$

where x_i is a vector of controls, $\Delta TECH_i$ a vector of technical change variables, $\Delta ORGA_i$ a vector of organisational change variables and υ_i an error term.

We interpret positive estimates $\hat{\delta}$ and $\hat{\gamma}$ as reduced-form evidence of a complementarity between technical/organisational change and the demand for skills. This interpretation relies on the *ceteris paribus* condition that we are able to observe plants that are similar in everything that is relevant for changes in the demand for skills, and that differ only in their technological/organisational practices. To mitigate potential missing variable biases, we introduce a broad set of controls (see section 3). However, it must be borne in mind that our results are partial correlations that do not necessarily have a causal interpretation.

The prediction from equation (2) is that technological and organisational changes are positively correlated with upward changes in the skill structure of the workforce. Skills, however, can be acquired through a variety of channels. In what follows, we consider three

possible channels: firms may upgrade the occupational structure of their workforce (which can be achieved though entries and exits or, alternatively through promotions); they may rely on excess turnover in order to acquire fresh skills; and/or, they may train their own workers. We interpret upward changes in the occupational structure through entries and exits as well as excess turnover as indicators of external labour market adjustments. Conversely, skill upgrading through promotions and training are seen as indicators of internal labour market strategies.

Decomposing changes in the occupational structure

Changes in firms' occupational structure following technological and/or organisational changes are usually estimated using standard labour share equations:

$$\Delta S_{ip} = x_i \beta_p + \Delta TECH_i \delta_p + \Delta ORGA_i \gamma_p + \upsilon_i \qquad (3)$$

where S_{ip} is the share of occupational group *p* in the workforce of firm *i*.

Such changes are the outcome of two different movements: (i) entries and exits of workers at various levels of the occupational structure and (ii) promotions of workers from lower to higher occupations. In order to distinguish both effects, we construct counterfactual changes in labour shares ($\Delta\widetilde{S}_{ip}$) based respectively on entries and exits only and on promotions only. Changes due to entries and exits only are given by:

$$\Delta\widetilde{S}_{ip} = \frac{L^{ip}_{t-1} + H^{ip}_{t} - E^{ip}_{t}}{L^{i}_{t-1} + H^{i}_{t} - E^{i}_{t}} - \frac{L^{ip}_{t-1}}{L^{i}_{t-1}} \qquad (4)$$

where L^{ip}_{t-1} is number of workers in occupation *p* in firm *i* at time *t-1*, H^{ip}_{t} is the number of entries in occupation *p* in firm *i* between time *t-1* and *t* and E^{ip}_{t} is the number of workers formerly employed in occupation *p* leaving firm *i* between time *t-1* and *t*. Similarly, L^{i}_{t}, H^{i}_{t}, and E^{i}_{t} respectively denote the total number of workers, entries and exits in firm *i* at time *t*.

Given that we do not have any direct information on promotions, changes in the occupational structure through promotions only ($\Delta\hat{S}_{ip}$) are defined as follows:

$$\Delta\hat{S}_{ip} = \frac{L^{ip}_{t} - H^{ip}_{t} + E^{ip}_{t}}{L^{i}_{t} - H^{i}_{t} + E^{i}_{t}} - \frac{L^{ip}_{t-1}}{L^{i}_{t-1}} \qquad (5)$$

where L_t^{ip} is the number of workers in occupation *p* in firm *i* at time *t*. The number of workers in occupation *p* at *t* is computed as a counterfactual including only promotions, i.e. the number of workers observed at *t* in occupation *p* minus entries plus exits into that group between *t-1* and *t*. In other words, it includes all people that would have been in occupation *p* at date *t* if there had been only promotions and no entries nor exits at this level between *t-1* and *t*. The corresponding labour share is computed by dividing this number of workers by what employment would have been in the firm at year *t* if no entries nor exits had taken place over the period.

We then estimate equation (3) separately for $\Delta\widetilde{S}_{ip}$ and $\Delta\hat{S}_{ip}$ by OLS, equation by equation. Note that the coefficients on the explanatory variables obtained when estimating equations (4) and (5) do not add up in general to those obtained when estimating equation (3): this is the case only when the level of employment in the firm remains constant over time.[2]

Upgrading skills through excess turnover and training

Another way to upgrade the skill structure of a firm following technological and organisational changes is through the addition of "fresh" workers by means of labour turnover. Turnover is, to some extent, a mechanical consequence of the upgrading of the occupational structure through entries/exits: there cannot be any upgrading of the occupational structure through entries/exits if there are no worker flows. However, as is well known from the literature on job and worker flows (for French firms, see Abowd, Corbel and Kramarz, 2003) worker flows (turnover) usually largely exceed what is needed for a given level of job flows. We therefore use a measure of 'excess turnover', i.e. turnover in excess to what is needed for a given change in the size of a group of workers. Specifically, excess turnover *et* in plant *i* and for group *p* is defined as:

$$et_{ip} \equiv \frac{H_{ip} + E_{ip}}{L_{ip}} - \left| \frac{H_{ip} - E_{ip}}{L_{ip}} \right| \tag{6}$$

We then estimate:

$$et_{ip} = x_i \xi_p + \Delta TECH_i n_p + \Delta ORGA_i q_p + v_{ip} \tag{7}$$

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[2] When the level of employment is constant, $H_t^i = E_t^i$ and $L_t^i = L_{t-1}^i$. Therefore,

$$\Delta S_{ip} = \frac{L_t^{ip} - L_{t-1}^{ip}}{L_{t-1}^i} = \frac{L_t^{ip} - H_t^{ip} + E_t^{ip} - L_{t-1}^{ip}}{L_{t-1}^i} + \frac{H_t^{ip} - E_t^{ip}}{L_{t-1}^i} = \Delta\hat{S}_{ip} + \Delta\widetilde{S}_{ip}.$$

by OLS equation by equation. $\hat{n}_p$ and $\hat{q}_p$ are the estimates of interest; positive values indicate that technical/organisational change is associated with an increased turnover of group *p*, beyond what is mechanically implied by the upgrading of occupational groups.

Similarly, skill upgrading through training needs to be analysed within each occupational group. Indeed, training rates are higher in high-skill groups, hence upgrading of the occupational structure through entries/exits mechanically generates an increase in training rates. Our data allows us to estimate training equations for a given occupational group:

$$T_{ip} = x_i \psi_p + \Delta TECH_i r_p + \Delta ORGA_i t_p + w_{ip} \qquad (7)$$

which we estimate by OLS. $\hat{r}_p$ and $\hat{t}_p$ are the estimates of interest; positive values indicate that technical/organisational change is associated with an increase in training, once controlled for composition effects due to the upgrading of the occupational structure through entries/exits.

2. The Data

Measuring technological and organisational changes within establishments and skill upgrading through our 3 channels requires combining several databases.

Information on technological and organisational changes comes from the *REPONSE survey* (RElations PrOfessionnelles et NégocationS d'Entreprise). In 1998, 2978 establishments were surveyed with senior managers being asked questions about industrial relations, implementation of new technologies and reorganisations[3]. The questions on organisational and technological changes relate to the previous three years, so that the survey provides measures of changes within establishments over the period 1996 to 1998.

Our preferred measure of organisational changes is based on the following question: *"During the last three years, did your establishment experience an important organisational change?"* It is a very general question but the advantage is that it explicitly refers to a *change* in organisation and that it is meaningful both in manufacturing and services. We define *organisational change* as a dummy variable equal to 1 when the manager answers yes and 0 otherwise. As robustness checks, we also use alternative variables capturing innovative work

[3] The REPONSE survey was conducted in 1992, 1998 and 2005. Panels that result from the merging of the three waves contain few observations and therefore can not be used. Moreover, one of the databases used in this paper (ESE) is not available from 1999 onward.

practices. The first one is a dummy variable equal to one if the firm has reduced the number of hierarchical layers between 1996 and 1998 (delayering). This variable nicely captures changes in organisation but it is likely to be mechanically correlated with changes in the occupational structure, which is a problem for us. Additional indicators of innovative work practices are just-in-time management methods (with clients or providers) and total quality management, which are probably more relevant in manufacturing than in service sectors.

Regarding technological change, the REPONSE survey provides information on the proportion of workers using computerised equipments, in particular computer and digital networks (less than 5%, 5 to 19%, 20 to 49%, 50% and more). Given that these technologies were at the very beginning of their life cycle in France in 1996, we assume that the proportion of workers using them in 1998 provides a good approximation of technological *adoption* over 1996-1998. More specifically, we define a dummy variable equal to 1 if 20% or more workers use computer and digital networks. The REPONSE survey also provides information on the proportion of workers using personal computers. We construct a dummy variable equal to 1 when this proportion is greater than 50%. Similarly, we also define a variable equal to 1 when the establishment uses computer assisted systems. Both variables are used to conduct robustness checks.

The REPONSE survey also provides detailed information on firms and establishments which we use as control variables in the regressions: firm characteristics (public/private, firm with one or several plants, listed on stock markets/non-listed), plant characteristics (rural or urban localisation, share of women, share of part-time workers), industrial relations (presence of union delegates), as well as a set of industry and plant size dummies.

In order to capture worker flows, we rely on two different sources. The DMMO has exhaustive data on entries and exits of workers in and out of establishments with 50 employees or more. The data is broken down into five occupational categories: managers and professionals[4], technicians and supervisors, clerks, skilled blue collars and unskilled blue collars. The EMMO has identical information on a representative sample of firms with less than 50 employees. We use this data to compute counterfactual changes in labour shares over 1996-1998, i.e. changes that are due only to entries and exits (resp. promotions) in the various occupations over the period. In order to do so – see equations (4) and (5) – we also use information on the level of employment in each occupational cell at the beginning and at the

[4] This category also includes engineers.

end of the period. This information is provided by the French survey of employment structure: the ESE, as of December 31st 1995 and 1998.

The last channel we consider for skill upgrading is training. The so-called "24-83" fiscal records provide firm-level data on the number of workers receiving training and the volume of training hours[5]. This information is broken down into five occupational categories which are identical to those in the DMMO-EMMO database. For each occupation, we thus compute both the proportion of workers receiving some training and the average number of training hours per worker. These are averaged over 1996-1998 in order to account for the fact that training may take some time to be implemented following technological and organisational changes.

Matching the five datasets and cleaning out establishments with implausible values for skill upgrading reduces our sample to 1,114 establishments – see the Data Appendix for details. Table A1 summarises all the variables used in our models. Our sample consists mainly of large plants (53% have more than 200 workers) belonging to multi-establishment firms of the private sector. 77% have a union delegate and less than half of them are listed. The manufacturing sector is over-represented in our sample: it accounts for 80% of total employment, compared to only 20% in the whole French economy. As a consequence, women account for only 35% of the labour force. Lastly, 37% of the plants employ more than 5% of part-time workers. Over 1996-1998, occupational changes have been substantial in our sample. The proportion of managers and professionals has increased on average in all plants, but the rise has been more important in establishments that have introduced technological and organisational changes. The share of technicians and supervisors has also increased, especially in large manufacturing plants. In contrast the share of clerks, skilled and unskilled blue-collars has decreased. This is particularly the case in innovative establishments, except for the proportion of skilled blue-collars which has increased following organisational changes. Finally, the reduction in the share of clerks and skilled blue-collars has been much stronger in services than in manufacturing, while the opposite holds for unskilled blue-collars. Much of these changes seem to be due to internal movements of the labour force. Consistently, training appears to be frequent, although access is greater in larger plants and for more skilled occupations. In what follows, we use regression analysis in order to further investigate these changes.

[5] The "24-83" records provide firm rather than plant-level data on training. Matching them with establishment-level data generates some measurement error that is likely to raise the standard errors in our estimates.

3. Results

3.a Technological change, organisational change and skill upgrading strategies

We first investigate the impact of technological and organisational changes upon the strategies adopted by firms to upgrade the skills of their workforce. Table 1 presents the results for the three different forms of skill upgrading we consider here: upward shift in the occupational structure through entries/exits versus promotions, excess turnover and training.

The first panel of Table 1.1 provides evidence of skill-biased technological and organisational changes. The use of computer and digital networks is associated with a significant shift upward in the occupational structure and, more specifically with an increase in the proportion of managers and professionals. Organisational changes are also associated with more managers and professionals, although the coefficient is significant at the 10% level only. These results are consistent with the existing evidence in the skill-bias literature: both technological and organisational changes tend to shift the occupational structure upward.

As a second step, we try to disentangle the role of internal versus external movements of the workforce in accounting for this upgrading of the occupational structure. Entries and exits do not seem to play a key role here. Following the introduction of new forms of organisation, all changes in the occupational structure take place through internal movements, i.e. through promotions. These tend to reduce the proportion of unskilled blue-collars in favour of skilled ones. Similarly, the use of computer and digital networks is associated with more workers being promoted into managerial positions. Part of the upward shift in the occupational structure following technological changes is also due to managers and professionals being hired from outside the firms. However, external movements only account for about one third of the overall increase in the proportion of managers and professionals, whereas promotions account for some 60%. This first set of results suggests that internal labour markets still play an important role when firms have to cope with increasing skill requirements. Most of the adjustment in the occupational structure actually takes place through promotions, whereas the relative importance of entries and exits to and from the external labour market remains rather limited.

However, firms may also try to upgrade the skill level of their workforce by bringing in "fresh workers" with new skills, beyond what would be necessary to upgrade the occupational structure through entries and exits. Table 1.2 thus investigates the partial correlations between

technological/organisational changes and excess turnover. We find no compelling evidence of such a correlation: organisational changes are not associated with excess turnover, whatever the category of workers we consider. Similarly, although the use of computer and digital networks is positively associated with excess turnover of clerks and unskilled blue-collars, the estimated coefficients are not significant at conventional levels. Overall, the external labour market does not appear as a key provider of new skills when firms introduce changes in their technology and/or work organisation.

In contrast, firms heavily rely on training in order to upgrade the skill level of their workforce. Table 1.3 has the partial correlations between technological and organisational changes on the one hand and two different measures of training on the other hand. As evidenced by Panel A, organisational changes increase the access to training for all categories of workers except for clerks - where the positive effect is not significant - and for unskilled blue-collars - where the coefficient is negative although insignificant. As for technological changes, they are associated with a higher proportion of trainees among managers and professionals but also among clerks whereas they have no significant impact upon the other groups of workers. When coming to the number of hours of training per worker, the effect of computer and digital networks remains positive and significant for managers and professionals, and clerks. In contrast, organisational changes are less systematically associated with an increase in training, with the estimates being positive and significant for technicians and supervisors only.

So, when considering the firms in our sample all together, our results suggest that the internal labour market still plays a key role in the adjustment of the skill level of the workforce following technological and organisational changes. Promotions account for the largest part of the upgrading in the occupational structure, and training is used as a complementary strategy to raise the skill level of workers in a majority of occupations – except for unskilled blue-collars.

In order to check the robustness of our results, we re-run our basic set of regressions using alternative measures of technological and organisational changes (see Appendix Tables A2 and A3). Tables A2-1 and A2-2 have the results for personal computers and computer assisted systems respectively. Both of them include our preferred measure of organisational change as well as all the control variables used in Tables 1 through 3. The pattern of results for personal computers is very similar to that of digital networks: the proportion of workers using a PC is correlated with an upward change in the occupational structure, which is mostly due to

internal labour market adjustments (except for managers and professionals where external movements are equally important). In contrast, the use of PCs is not significantly associated with excess turnover, whereas it is correlated with more training being offered, in particular to skilled blue-collars. The results are less stark when using computer assisted systems as an explanatory variable (Table A2-2): it does not generate any significant change in the occupational structure. However, it is associated with lower labour turnover, especially for skilled blue-collars and with more hours of training for managers and professionals. Similar tests are conducted for alternative measures of organisational change (Tables A3-1 to A3-3). They all include the use of computer and digital networks as a control variable – in addition to our standard controls. Although not as strong as for the organisational change variable, the results are very similar: when the occupational structure is upgraded, this is done through internal rather than external labour market adjustments – see Tables A3-1 and A3-2 for delayering and just-in-time. New work practices (and in particular total quality management) are associated, if anything, with reduced labour turnover. Moreover, they tend to raise the number of hours of training offered to unskilled blue-collars (following delayering) and to technicians and supervisors (when the establishment uses just-in-time management methods).

The important role of the internal labour market in upgrading the skill level of the workforce therefore seems to be a characteristic of the French human resource management model. One can wonder however whether this model is common to all sectors of the French economy or whether it is specific to some of them.

3.b The sectoral dimension of skill upgrading strategies

In order to investigate this issue, we split our sample across manufacturing and services and re-run all the estimates. The results are reported in Tables 2.1 to 2.3. As can be seen from Panel A of Table 2.1, changes in the occupational structure following organisational and technological changes are much more important in the manufacturing sector than in services. In the former, organisational changes appear to be biased against unskilled labour and in favour of clerks, while the use of computer and digital networks is biased in favour of managerial positions. In services, only technological change appears to be skill-biased in the sense that it is associated with a higher proportion of managers and professionals. Moreover, promotions play a much more important role in manufacturing than in services. They account for almost all changes in the occupational structure in manufacturing industries, whereas in

services the increase in the share of managers and professionals following technological changes is mainly due to entries and exits from the external labour market.

The pattern of results regarding excess turnover (Table 2.2) indicates that adjustments on the external labour market exist in the manufacturing sector, for managers and professionals and following organisational changes. This is not the case in services where neither technological nor organisational changes are significantly correlated with excess turnover. However, this cannot be interpreted as an indication of external adjustments being more widespread in manufacturing than in services. Training is indeed widely used by manufacturing firms in order to upgrade the skill level of the workforce, whereas this is not the case in the service sector. As evidenced in panels A and B of Table 2.3, both technological and organisational changes are associated with a greater proportion of trainees in the various occupational groups in manufacturing sectors. This is the case for managers and professionals, clerks and skilled blue-collars (at the 10% significance level) when computer and digital networks are used and for technicians and supervisors, skilled blue-collars and managers and professionals (at the 10% level) when important changes in organisation are introduced. The results are weaker for organisational changes when we consider the number of training hours per worker, but they remain very strong for technological changes. This is not the case in services where the only significant effect is on managers and professionals and following organisational changes.

This second set of results thus suggests that the resistance of internal labour markets is particularly strong in the manufacturing sector. Changes in the occupational structure mostly take place through promotions and training is a very widespread strategy in order to upgrade the skill level of the workforce. The situation is quite different in services where technological and organisational changes are not associated with much effort to upgrade the skill level of the workforce. Adjustments on the internal labour markets are very limited but external adjustments are not more frequent. This suggests that innovations are not so strongly associated with rising skill requirements in services as they are in manufacturing sectors. And this, independently of the choice made by firms between internal versus external labour market adjustments.

One question raised by these results has to do with the potential role of firm's size. Is the resistance of internal labour markets really specific to the manufacturing sector or is it due, and to what extent, to the fact that manufacturing firms are on average larger than service ones? Size could well be a key factor because internal labour markets are probably wider and therefore less costly to use in large firms than in small ones. More generally, this raises the

question of the circumstances in which firms may have an incentive to choose internal rather than external labour market adjustments.

3.c Skill upgrading strategies according to firms' size and density on the local labour market

One reason for firms to choose internal rather than external labour market adjustments is, of course, the relative costs of both strategies. As mentioned above, the cost of internal labour market adjustments should be decreasing in firm size. Small firms do not necessarily have the right people to promote and/or train internally, whereas large ones have large pools of workers among whom they may find the required skills, either immediately or after some training. Similarly, the cost of external labour market adjustments is likely to be impacted by the size of the local labour market: all other things equal, the larger it is, the less costly it will be for firms to find the workers with the skills they need. In order to test the impact of the related costs upon firm's strategies, we re-estimate our basic set of regressions after splitting our sample across size and local labour market density.

Tables 3.1 to 3.3 investigate the various channels used to upgrade the skill structure in large versus small plants. Large plants are defined as those having more than 200 workers (the median size). Overall changes in the occupational structure following technological and organisational changes appear slightly more frequent in small firms than in large ones: the use of computer and digital networks affects both managers and professionals (positively) and clerks (negatively) in the former whereas they only affect managers and professionals in the latter. Whatever the size of the firm though, these occupational changes appear to be mostly due to promotions, with entries and exits being essentially insignificant. Excess turnover increases with organisational changes for skilled blue-collars in small plants whereas the negative effects (on skilled blue-collars in small plants and unskilled blue-collars in large ones) are not statistically significant at conventional levels. As regards training, firms' strategies do not significantly differ across size. The precision of the estimates is often limited (at the 10% level only), but training seems to be used both by small and large firms following technological and organisational changes. Overall, the choice of upgrading the skill level of the workforce through internal rather than external labour market adjustments does not seem to depend much on firms' size.

Regarding the density of the local labour market, the patterns of results provided in Tables 4.1 to 4.3 appear to be more differentiated. High-density (resp. low-density) areas are defined as

having a density of workers above (resp. below) the median. As evidenced in Table 4.1, upgrading of the occupational structure through promotions is much more frequent in high-density areas than in low-density ones. Entries and exits are also more frequent, at least for managers and professionals. So, from this first set of results, one cannot ascribe upward changes in the occupational structure to any specific channel in low-density areas, whereas both promotions and, to a smaller extent, entries and exits seem to be used in high-density local labour markets. As regards excess turnover, it is clearly more frequent in high-density environments than in low-density ones following technological changes. The pattern of results is more balanced for the access to training which seems to increase with technological and organisational changes in both types of labour markets. However, when coming to the number of training hours per worker, no significant effect is found in high-density areas whereas both new technologies and new forms of work organisation are associated with more training hours in firms located in low-density labour market. Overall, skill upgrading through external labour market adjustments appears to be more widespread in high-density areas than in low-density ones. Conversely training on the internal labour market is more widely used in low-density areas, even if this does not lead to more promotions taking place.

Overall, this second set of results shows heterogeneous responses along different dimensions: sector, plant size and local labour market characteristics. As these dimensions are not orthogonal, it is important to check whether the pair wise comparisons made so far by stratifying the sample still hold when all dimensions are analysed simultaneously. Appendix table A4 shows that this is broadly the case. Interactions between the technical/organizational change variables on the one hand, and indicator variables for high-density labour markets, large plants and services, on the other hand, are introduced in the same regressions; the reference is the apparent effect for small manufacturing plants located in low-density local labour markets. Other things kept equal, high-density labour markets witness more adjustments of the occupational structure when adopting new technologies and organisational practices. This takes place through more important internal movements, and through more external movements (though the latter difference is not statistically significant). They also witness more excess turnover. Large plants witness significantly less excess turnover among skilled blue-collars when implementing organizational changes, and more training when implementing technological changes. All this is consistent with the simpler stratified analyses.

4. Discussion

In this paper, we have taken a fresh look at the issue of skill-biased technical and organisational change, following Mincer's insight that it is important to know whether the skill upgrading of the firms' workforce takes place through hiring or training for the new skills. Assessing the responses of internal labour markets to changes in the technology and the organisation of firms seems indeed useful to understand recent evolutions in labour markets better than by just modelling them as price and quantity adjustments on a spot market.

Our empirical results suggest that most of the adjustments that have taken place in France following the introduction of new technologies and innovative workplace practices have gone through the internal rather than external labour market. As already evidenced by many papers in the literature, technological and organisational changes are associated with and upward shift in the occupational structure. But this is largely achieved through promotions rather than entries and exits from the external labour market. Moreover, when introducing new technologies and/or organisational practices firms massively rely on training in order to upgrade the skill level of their workforce, whereas the use of excess turnover as a provider of new skills remains rather limited. This resistance of internal labour markets is particularly strong in manufacturing sectors. In services, adjustments in the skill level of the workforce appear much less important following technological and organisational changes. This difference between manufacturing and service sectors does not only capture a size effect: when splitting our sample across firm's size no clear pattern of human resource management appears. In contrast, external labour market adjustments tend to be more frequent in firms located in high-density areas, whereas training is more widespread in low-density zones. One explanation for this pattern of results may be that the relative cost of external rather than internal labour market adjustments is higher when employment density is lower.

These results suggest adding one step to the simple story of skill-biased technical change with which we started. Facing lower computer prices, firms had incentives to adopt skilled-biased technologies and organisational practices and to employ more skilled labour. But to do so, they faced a trade-off: either find the new skills on the external labour market or find them on their internal labour market by training their existing workforce. In France, they predominantly chose the latter strategy, though the reliance on the external labour market was stronger in dense local labour markets with high supply of skilled labour, as external adjustments were less difficult.

This story has the virtue of simplicity and is consistent with the partial correlations we find. However, in the absence of causal estimates, we cannot prove that this mechanism is the right one. We briefly consider alternative stories, and examine whether they are also consistent with the evidence we provide.

The first story is one of spurious correlations due to unobserved shocks. A first way to see that is that firms that are hit by unfavourable shocks (say, a falling demand for their product) have to cut costs. To that end, they adopt cost saving technologies and new forms of work organisation; they also downsize, and the burden of the adjustment is disproportionately born by the unskilled. This sequence of events would generate a spurious correlation between technical/organisational changes and upgrading of the occupational structure through entries and exits. Therefore, wrongly ignoring the potential role of unobserved shocks would make us overestimate the external labour market response to technical and organisational changes. This rather reinforces our result on the predominance of internal adjustments. However, unobserved shocks may also work the other way round. Firms that are hit by a positive shock may introduce new technologies and innovative work practices (because they have more cash available for investment). The French regulation on the financing of continuous training is such that over the 1996-1998 period, all firms had to spend at least 1.5% of their wage bill on training. For those firms for which this constraint is binding, any positive shock that raises the wage bill will mechanically generate an increase in training expenditure. In this case, the positive correlation we find between new technologies/organisational changes and training may be spurious. In order to check whether this is the case, we re-ran our training regressions on the sub-sample of firms spending more than 2% of their wage bill on training. For these firms, the legal minimum is not binding so that there is no reason that an increase in their wage bill should lead them to invest more in training. When doing this, our results are virtually unchanged[6]. Another way to control for positive shocks in our regressions is to introduce changes in firm's size over 1996-1998 as a control variable. Here again, the correlations between technological/organisational changes and training are unchanged[7].

[6] The coefficients (standard errors) of the organisational change variable in the regression for the proportion of trainees are: 7.07 (2.04) for managers and professionals, 10.3 (3.33) for technicians an supervisors, 2.88 (2.01) for clerks, 5.54 (2.56) for skilled blue-collars and -15.42 (22.94) for unskilled blue-collars. For technical change, the corresponding coefficients are: 6.59 (2.08) for managers and professionals, 4.21 (3.00) for technicians an supervisors, 4.67 (1.99) for clerks, 3.36 (2.09) for skilled blue-collars and -4.54 (14.94) for unskilled blue-collars.

[7] The coefficients (standard errors) of the organisational change variable in the regression for the proportion of trainees are: 5.12 (2.41) for managers and professionals, 8.28 (3.20) for technicians an supervisors, 2.28 (1.91) for clerks, 5.54 (2.56) for skilled blue-collars and -13.75 (20.44) for unskilled blue-collars. For technical change, the corresponding coefficients are: 4.73 (2.04) for managers and professionals, 2.66 (2.75) for technicians an

A second story is more specific to France. Starting in 1993, successive governments have introduced fiscal measures to reduce the labour cost of low-wage workers. These measures have had the largest impact on firms employing a high proportion of low-skill workers. As a result, these firms were less induced to adopt new technologies (as long as they are substitutes to unskilled labour) while they had incentives to hire even more low-skill workers. It might also have changed their behaviour toward training, though the direction is not obvious: firms might have refrained from training those workers who would not have been eligible for the tax exemption had their wage increased following training. This, however, does not concern high-wage workers whose training appears to be highly correlated with new technologies in our data. Moreover, the additional contingents of low-wage workers paid at the minimum wage would probably not get any wage increase following training, given that their productivity would, most probably, remain below the minimum wage. Overall, it is unclear whether training should have decreased or increased in low-wage firms that did not adopt new technologies. The story tends to go in the direction of overestimating the adjustments through the external labour market.

The third story has to do with imperfect competition and rent sharing. Firms that earn high profits can more easily invest in the last consultant's hype and afford costly new technologies and organizational practices. They can also afford to train their workers and offer them promotions. The workers are attached to the firm if they get a share of the rent. This story would entail a spurious correlation between technical/organisational changes, internal movements and training. As such, it directly competes with our story in order to account for our empirical evidence. There are three arguments against this story, however: first, technological and organisational innovations are not just management fads: they actually raise firms' productivity (see Black and Lynch, 2004). Moreover, internal labour market adjustments are stronger in the manufacturing sector than in services, whereas manufacturing is more exposed to international competition than services, hence less likely to provide firms and workers with high rents. Third, this story does not account for the sensitivity to local labour market conditions when deciding between internal and external labour market adjustments.

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supervisors, 5.07 (1.98) for clerks, 3.04 (1.99) for skilled blue-collars and -7.72 (17.25) for unskilled blue-collars.

Overall, we view our results as providing evidence that internal labour markets have remained a viable strategy for French firms to upgrade the skill level of their workforce following the adoption of new technologies and organisational practices.

Where do we go from here? The resistance of internal labour markets in France, even in the context of technological and organisational innovations, could be the sign that internal labour markets are not necessarily deemed to die in knowledge-based economies. However, it could also be the outcome of a highly protective employment protection legislation (see OECD, 2004): firms may rely on internal labour market adjustments because going on the external labour market would simply be too costly. This idea has long been put forward by Bishop (1991). However, recent evidence by Bassanini *et al.* (2007) suggests that the amount of training provided by firms would actually be negatively correlated to employment protection legislation. In order to get a better understanding of these relations, the comparison of France with other countries would be potentially very fruitful. The USA or the UK stand as particularly good candidates given that employment protection legislation is much less strict in these countries than in France. This would allow to check whether the introduction of new technologies and workplace practices have had a different impact on firms' labour market strategies in these countries. It would also permit to compare the various determinants of skill upgrading strategies across countries. An important avenue for future research is indeed to tie down the extent to which labour market institutions are likely to affect firms' strategies in terms of human resource management.

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TABLE 1.1
Changes in occupational structure due to internal and external movements 1996-1998 (all sectors)

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			A. Overall changes in the occupational structure		
Organisational change	0.36*	-0.26	-0.11	0.46	-0.46
	(0.20)	(0.28)	(0.29)	(0.38)	(0.35)
Technical change (use of digital networks)	0.95***	-0.20	-0.40	-0.06	-0.29
	(0.19)	(0.27)	(0.27)	(0.34)	(0.32)
Number of observations	1114	1114	1114	1114	1114
R-squared	0.08	0.04	0.05	0.04	0.05
			B. Internal movements		
Organisational change	0.24	-0.25	0.03	0.65*	-0.67**
	(0.19)	(0.30)	(0.31)	(0.38)	(0.34)
Technical change (use of digital networks)	0.60***	0.01	-0.28	-0.17	-0.16
	(0.19)	(0.28)	(0.28)	(0.34)	(0.33)
Number of observations	1114	1114	1114	1114	1114
R-squared	0.06	0.02	0.04	0.05	0.07
			C. External movements		
Organisational change	0.14	-0.00	-0.19	-0.16	0.21
	(0.16)	(0.23)	(0.19)	(0.27)	(0.27)
Technical change (use of digital networks)	0.34**	-0.21	-0.09	0.11	-0.15
	(0.15)	(0.20)	(0.19)	(0.24)	(0.25)
Number of observations	1114	1114	1114	1114	1114
R-squared	0.04	0.05	0.06	0.02	0.03

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part-time) and 16 sectors.

TABLE 1.2 - Excess turnover (all sectors)

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			Excess turnover		
Organisational change	0.74	5.76	-3.72	5.39	-52.37
	(2.15)	(5.58)	(7.85)	(4.95)	(64.04)
Technical change	-0.82	-1.64	12.44*	5.50	153.80*
(use of digital networks)	(2.18)	(2.69)	(7.00)	(3.93)	(90.44)
Number of observations	1090	1094	1104	1010	790
R-squared	0.12	0.12	0.13	0.12	0.03

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions include controls for plant size (dummy variable for plants with more than 200 employees), being located in a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 sectors.

TABLE 1.3 – Training (all sectors)

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			A. Number of trainees (per 100 workers)		
Organisational change	6.14***	8.35***	2.28	5.12**	-13.50
	(2.02)	(3.22)	(1.91)	(2.41)	(20.28)
Technical change	4.81**	3.02	5.07**	3.16	-8.11
(use of digital networks)	(2.03)	(2.81)	(1.97)	(2.05)	(17.46)
Number of observations	1097	1052	1087	892	646
R-squared	0.14	0.11	0.12	0.10	0.03
			B. Training hours per worker		
Organisational change	1.69*	1.82**	1.28*	0.36	-0.49
	(0.94)	(0.91)	(0.74)	(0.74)	(1.13)
Technical change	2.83***	1.30	1.97***	1.02	-0.02
(use of digital networks)	(0.95)	(0.87)	(0.76)	(0.78)	(1.17)
Number of observations	1095	1042	1083	888	416
R-squared	0.14	0.15	0.12	0.06	0.05

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part-time) and 16 sectors.

TABLE 2.1
Changes in occupational structure due to internal and external movements 1996-1998
Manufacturing and services

	Manufacturing					Services				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
	A. Overall changes in the occupational structure					**A. Overall changes in the occupational structure**				
Organisational change	0.39	-0.42	0.47**	0.57	-1.00**	0.30	-0.00	-1.05	0.32	0.43
	(0.25)	(0.31)	(0.23)	(0.52)	(0.51)	(0.36)	(0.55)	(0.64)	(0.53)	(0.36)
Technical change	0.85***	-0.24	-0.21	-0.31	-0.08	0.91***	0.03	-0.75	0.34	-0.53
(use of digital networks)	(0.23)	(0.33)	(0.22)	(0.51)	(0.48)	(0.31)	(0.46)	(0.58)	(0.40)	(0.38)
Number of observations	641	641	641	641	641	473	473	473	473	473
R-squared	0.10	0.06	0.04	0.07	0.05	0.08	0.04	0.07	0.02	0.08
	B. Internal movements					**B. Internal movements**				
Organisational change	0.17	-0.34	0.51**	0.74	-1.08**	0.35	-0.05	-0.85	0.52	0.03
	(0.23)	(0.31)	(0.25)	(0.49)	(0.48)	(0.34)	(0.61)	(0.68)	(0.59)	(0.42)
Technical change	0.71***	-0.10	-0.11	-0.39	-0.11	0.30	0.27	-0.51	0.22	-0.28
(use of digital networks)	(0.23)	(0.33)	(0.23)	(0.50)	(0.49)	(0.32)	(0.51)	(0.60)	(0.46)	(0.42)
Number of observations	641	641	641	641	641	473	473	473	473	473
R-squared	0.07	0.03	0.05	0.06	0.06	0.08	0.02	0.05	0.03	0.04
	C. External movements					**C. External movements**				
Organisational change	0.18	0.01	-0.05	-0.22	0.08	0.07	-0.10	-0.34	-0.09	0.45
	(0.18)	(0.22)	(0.16)	(0.36)	(0.39)	(0.29)	(0.46)	(0.44)	(0.42)	(0.34)
Technical change	0.18	-0.06	-0.15	0.02	0.01	0.54**	-0.36	-0.08	0.17	-0.27
(use of digital networks)	(0.18)	(0.21)	(0.15)	(0.35)	(0.37)	(0.25)	(0.39)	(0.40)	(0.33)	(0.29)
Number of observations	641	641	641	641	641	473	473	473	473	473
R-squared	0.05	0.04	0.05	0.03	0.03	0.02	0.09	0.08	0.02	0.06

Notes

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 2.2
Excess turnover in manufacturing and services

	Excess turnover									
	Manufacturing					Services				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
Organisational change	3.78**	1.70	4.76	4.26	-15.56	-5.14	14.19	-12.27	9.30	-96.90
	(1.51)	(1.92)	(4.92)	(4.98)	(29.08)	(5.51)	(14.40)	(18.37)	(11.64)	(178.04)
Technical change	0.36	0.83	7.28*	5.03	39.21	-3.57	-3.71	20.08	5.79	380.42
(use of digital networks)	(1.37)	(1.56)	(3.98)	(3.24)	(35.68)	(5.37)	(5.64)	(15.34)	(9.35)	(262.90)
Number of observations	635	634	634	631	538	455	460	470	379	252
R-squared	0.07	0.07	0.04	0.08	0.03	0.11	0.11	0.08	0.12	0.05

Notes
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 2.3
Training in manufacturing and services

	Manufacturing					Services				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
	A. Number of trainees (per 100 workers)					A. Number of trainees (per 100 workers)				
Organisational change	4.14*	11.66***	1.75	4.89**	7.01	10.33***	4.34	3.50	4.49	-95.11
	(2.37)	(4.30)	(2.54)	(2.30)	(5.65)	(3.62)	(4.63)	(3.08)	(7.91)	(99.58)
Technical change (use of digital networks)	8.86***	5.01	7.18***	3.49*	5.38	-0.19	0.43	2.45	1.01	-56.71
	(2.40)	(3.87)	(2.55)	(2.02)	(4.96)	(3.54)	(4.26)	(3.24)	(6.66)	(78.76)
Number of observations	633	625	624	625	463	464	427	463	267	183
R-squared	0.16	0.12	0.10	0.14	0.09	0.15	0.10	0.14	0.07	0.05
	B. Training hours per worker					B. Training hours per worker				
Organisational change	0.88	1.90*	1.37	0.53	-0.52	3.31**	1.70	1.13	-1.03	-1.91
	(1.17)	(1.03)	(1.00)	(0.81)	(1.32)	(1.58)	(1.65)	(1.15)	(1.73)	(1.86)
Technical change (use of digital networks)	4.72***	2.22**	3.16***	0.32	-0.77	0.53	-0.14	0.36	2.34	3.27
	(1.26)	(1.02)	(1.03)	(0.71)	(1.31)	(1.46)	(1.61)	(1.17)	(2.27)	(2.44)
Number of observations	631	620	622	624	315	464	422	461	264	101
R-squared	0.17	0.22	0.12	0.04	0.04	0.12	0.09	0.11	0.13	0.16

Notes

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 3.1
Changes in occupational structure due to internal and external movements 1996-1998 in small and large plants

	Small plants (less than 200 workers)					Large plants (more than 200 workers)				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
	A. Overall changes in the occupational structure					**A. Overall changes in the occupational structure**				
Organisational change	0.40	-0.27	-0.19	-0.02	0.09	0.29	-0.28	-0.09	0.69	-0.61
	(0.37)	(0.52)	(0.55)	(0.69)	(0.54)	(0.22)	(0.30)	(0.31)	(0.45)	(0.45)
Technical change	0.96***	0.19	-1.21***	0.12	-0.06	0.88***	-0.44	0.05	-0.09	-0.40
(use of digital networks)	(0.33)	(0.46)	(0.43)	(0.53)	(0.44)	(0.22)	(0.34)	(0.29)	(0.42)	(0.43)
Number of observations	527	527	527	527	527	587	587	587	587	587
R-squared	0.10	0.04	0.06	0.07	0.08	0.08	0.08	0.15	0.06	0.10
	B. Internal movements					**B. Internal movements**				
Organisational change	0.61*	-0.11	-0.28	0.37	-0.60	-0.02	-0.31	0.10	0.80*	-0.58
	(0.37)	(0.58)	(0.61)	(0.70)	(0.55)	(0.18)	(0.31)	(0.29)	(0.45)	(0.45)
Technical change	0.44	0.61	-1.05**	-0.12	0.11	0.75***	-0.34	0.06	-0.08	-0.39
(use of digital networks)	(0.36)	(0.50)	(0.47)	(0.57)	(0.51)	(0.19)	(0.32)	(0.29)	(0.43)	(0.42)
Number of observations	527	527	527	527	527	587	587	587	587	587
R-squared	0.06	0.04	0.05	0.04	0.07	0.11	0.05	0.19	0.08	0.11
	C. External movements					**C. External movements**				
Organisational change	-0.14	-0.34	-0.05	-0.13	0.66	0.30*	0.19	-0.19	-0.22	-0.09
	(0.29)	(0.43)	(0.39)	(0.46)	(0.46)	(0.17)	(0.23)	(0.19)	(0.33)	(0.32)
Technical change	0.48*	-0.33	0.00	0.14	-0.29	0.14	-0.16	-0.05	0.07	-0.00
(use of digital networks)	(0.26)	(0.37)	(0.34)	(0.39)	(0.37)	(0.16)	(0.21)	(0.20)	(0.31)	(0.33)
Number of observations	527	527	527	527	527	587	587	587	587	587
R-squared	0.06	0.08	0.07	0.08	0.07	0.05	0.09	0.13	0.03	0.06

Notes

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 3.2
Excess turnover in small and large plants

	Excess turnover									
	Small plants (less than 200 workers)					Large plants (more than 200 workers)				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
Organisational change	1.32	13.76	3.54	21.82**	-78.96*	0.78	0.75	-6.16	-5.39*	-46.20
	(3.93)	(13.94)	(12.63)	(10.72)	(43.78)	(2.33)	(3.20)	(9.58)	(3.00)	(110.34)
Technical change (use of digital networks)	-0.16	-5.47	9.19	2.50	42.17	-2.03	0.80	12.37	7.25**	234.10
	(3.71)	(5.73)	(11.70)	(7.94)	(59.50)	(2.62)	(2.05)	(8.40)	(3.58)	(153.27)
Number of observations	511	510	517	459	339	579	584	587	551	451
R-squared	0.13	0.12	0.16	0.14	0.10	0.15	0.16	0.13	0.14	0.07

Notes

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 3.3
Training in small and large plants

	Small plants (less than 200 workers)					Large plants (more than 200 workers)				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
	A. Number of trainees (per 100 workers)					**A. Number of trainees (per 100 workers)**				
Organisational change	10.52***	9.16**	5.27*	1.53	5.49	3.74*	8.73*	0.17	8.37**	-25.96
	(3.72)	(4.19)	(3.09)	(4.03)	(5.53)	(2.25)	(4.47)	(2.53)	(3.33)	(34.81)
Technical change (use of digital networks)	6.02*	1.15	4.69*	-2.33	7.27	3.61	3.77	5.37*	4.85*	-11.87
	(3.46)	(3.44)	(2.68)	(3.81)	(9.29)	(2.34)	(4.27)	(2.89)	(2.61)	(20.69)
Number of observations	514	485	511	394	274	583	567	576	498	372
R-squared	0.12	0.11	0.12	0.08	0.08	0.12	0.06	0.07	0.15	0.04
	B. Training hours per worker					**B. Training hours per worker**				
Organisational change	3.25**	2.00	2.27*	0.63	2.08	1.15	2.19**	0.40	-0.15	-1.79
	(1.57)	(1.59)	(1.22)	(1.32)	(2.43)	(1.17)	(1.09)	(0.99)	(0.91)	(1.33)
Technical change (use of digital networks)	3.26**	0.70	1.13	0.90	1.57	2.37**	1.29	2.71**	0.66	-1.39
	(1.51)	(1.42)	(1.02)	(1.30)	(2.11)	(1.20)	(1.09)	(1.13)	(0.92)	(1.35)
Number of observations	513	484	508	391	142	582	558	575	497	274
R-squared	0.08	0.08	0.08	0.06	0.36	0.13	0.17	0.10	0.13	0.05

Notes

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 4.1
Changes in occupational structure due to internal and external movements 1996-1998 in low and high-density labour markets

	Low-density local labor market					High-density local labor market				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
	A. Overall changes in the occupational structure					**A. Overall changes in the occupational structure**				
Organisational change	0.05	-0.21	0.17	0.25	-0.26	0.57	-0.23	-0.31	0.73	-0.76*
	(0.22)	(0.35)	(0.26)	(0.58)	(0.58)	(0.35)	(0.44)	(0.49)	(0.50)	(0.44)
Technical change (use of digital networks)	0.52**	0.09	0.02	-1.02*	0.39	1.43***	-0.53	-0.73	0.61	-0.78*
	(0.23)	(0.36)	(0.27)	(0.52)	(0.49)	(0.30)	(0.42)	(0.47)	(0.43)	(0.40)
Number of observations	550	550	550	550	550	564	564	564	564	564
R-squared	0.08	0.06	0.08	0.08	0.06	0.08	0.07	0.07	0.06	0.08
	B. Internal movements					**B. Internal movements**				
Organisational change	0.01	-0.01	0.34	0.11	-0.44	0.44	-0.32	-0.17	1.08**	-1.03**
	(0.23)	(0.37)	(0.29)	(0.55)	(0.51)	(0.31)	(0.49)	(0.53)	(0.51)	(0.47)
Technical change (use of digital networks)	0.33	0.33	-0.03	-0.83	0.20	0.92***	-0.39	-0.55	0.32	-0.30
	(0.26)	(0.37)	(0.29)	(0.51)	(0.49)	(0.28)	(0.43)	(0.48)	(0.46)	(0.44)
Number of observations	550	550	550	550	550	564	564	564	564	564
R-squared	0.06	0.06	0.07	0.09	0.09	0.07	0.03	0.05	0.06	0.08
	C. External movements					**C. External movements**				
Organisational change	0.08	-0.15	-0.27	0.14	0.20	0.14	0.08	-0.13	-0.35	0.26
	(0.17)	(0.24)	(0.26)	(0.42)	(0.43)	(0.27)	(0.36)	(0.29)	(0.34)	(0.34)
Technical change (use of digital networks)	0.18	-0.21	0.18	-0.25	0.11	0.51**	-0.16	-0.27	0.37	-0.44
	(0.17)	(0.25)	(0.24)	(0.36)	(0.39)	(0.23)	(0.31)	(0.28)	(0.33)	(0.30)
Number of observations	550	550	550	550	550	564	564	564	564	564
R-squared	0.06	0.09	0.10	0.05	0.05	0.04	0.08	0.07	0.03	0.06

Notes

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 4.2
Excess turnover in low and high-density labour markets

	Excess turnover									
	Low-density local labor market					High-density local labor market				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
Organisational change	2.61	8.03	-9.44	5.48	-13.84	-1.10	3.76	4.98	5.56	-92.90
	(3.39)	(11.11)	(8.28)	(6.13)	(42.65)	(2.91)	(3.07)	(13.37)	(7.23)	(114.14)
Technical change	-1.97	-5.73	-0.53	-5.26	37.21	0.46	3.05	25.76**	17.16***	282.15
(use of digital networks)	(3.03)	(4.34)	(5.77)	(4.58)	(48.24)	(3.29)	(2.85)	(12.57)	(6.16)	(176.40)
Number of observations	536	537	543	518	428	554	557	561	492	362
R-squared	0.14	0.13	0.23	0.17	0.06	0.11	0.20	0.11	0.13	0.07

Notes
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

TABLE 4.3
Training in low and high-density labour markets

	Low-density local labor market					High-density local labor market				
	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
	A. Number of trainees (per 100 workers)					**A. Number of trainees (per 100 workers)**				
Organisational change	6.30**	6.13	3.90	1.18	-0.21	7.16***	12.90**	1.57	9.87**	-32.71
	(3.09)	(3.93)	(2.95)	(2.74)	(2.66)	(2.63)	(5.32)	(2.63)	(3.98)	(53.83)
Technical change	7.80**	-0.88	4.53*	3.15	2.52	1.96	5.78	5.18*	2.94	-42.09
(use of digital networks)	(3.14)	(4.22)	(2.72)	(2.82)	(2.84)	(2.63)	(4.06)	(2.83)	(3.16)	(57.50)
Number of observations	538	522	532	473	363	559	530	555	419	283
R-squared	0.18	0.15	0.18	0.11	0.18	0.15	0.11	0.10	0.12	0.04
	B. Training hours per worker					**B. Training hours per worker**				
Organisational change	2.50*	1.97	2.22**	0.86	0.28	1.71	2.06	0.36	-0.84	-0.93
	(1.40)	(1.22)	(1.11)	(1.02)	(1.45)	(1.30)	(1.34)	(1.03)	(1.13)	(1.71)
Technical change	3.33**	1.24	2.69***	0.23	-0.86	2.04	1.15	1.37	1.73	1.43
(use of digital networks)	(1.43)	(1.23)	(1.04)	(0.87)	(1.61)	(1.31)	(1.25)	(1.10)	(1.24)	(2.13)
Number of observations	538	518	531	470	241	557	524	552	418	175
R-squared	0.13	0.20	0.16	0.04	0.09	0.19	0.14	0.10	0.14	0.11

Notes

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public firms, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 industries.

Appendix Table A1
Descriptive Statistics

	All plants	Subsample of plants that implemented… … organisational change	… technical change	Manufacturing only	Services only	Small plants (less than 200)	Large plants (more than 200)	Low-density local labour market	High-density local labour market
Change of labour share (in %)									
Managers and professionals	0,77	1,14	1,39	0,93	0,54	0,67	0,85	0,43	1,10
Technicians and supervisors	0,56	0,43	0,43	0,72	0,36	0,27	0,82	0,67	0,46
Clerks	-0,38	-0,53	-0,62	-0,27	-0,53	-0,32	-0,43	-0,06	-0,68
Skilled blue collars	-0,01	0,29	-0,04	0,16	-0,24	-0,03	0,00	0,19	-0,21
Unskilled blue collars	-0,94	-1,34	-1,16	-1,54	-0,13	-0,60	-1,25	-1,23	-0,66
Change of labour share through entries and exits (in %)									
Managers and professionals	-0,07	0,09	0,15	0,07	-0,26	-0,20	0,05	-0,15	0,01
Technicians and supervisors	-0,13	-0,18	-0,33	-0,17	-0,09	-0,07	-0,19	-0,05	-0,22
Clerks	0,18	0,08	0,20	0,14	0,25	0,07	0,29	0,15	0,22
Skilled blue collars	-0,41	-0,49	-0,34	-0,67	-0,05	-0,49	-0,34	-0,49	-0,33
Unskilled blue collars	0,43	0,50	0,31	0,63	0,15	0,69	0,20	0,54	0,32
Change of labour share through internal movements (in %)									
Managers and professionals	0,92	1,14	1,30	0,90	0,93	0,99	0,85	0,67	1,16
Technicians and supervisors	0,79	0,70	0,85	0,96	0,56	0,47	1,08	0,81	0,78
Clerks	-0,64	-0,70	-0,87	-0,41	-0,95	-0,53	-0,73	-0,35	-0,91
Skilled blue collars	0,40	0,82	0,31	0,85	-0,21	0,47	0,34	0,75	0,06
Unskilled blue collars	-1,47	-1,95	-1,60	-2,31	-0,34	-1,40	-1,54	-1,87	-1,08
Excess turnover (in %)									
Managers and professionals	24,12	23,96	21,77	18,54	31,89	25,37	23,01	24,17	24,06
Technicians and supervisors	25,13	25,70	19,24	13,95	40,55	33,56	17,78	26,77	23,56
Clerks	61,10	55,00	59,91	30,13	102,88	76,14	47,86	55,31	66,70
Skilled blue collars	26,42	26,30	27,26	16,18	43,47	35,69	18,70	24,39	28,56
Unskilled blue collars	155,88	122,49	223,36	108,07	257,93	126,42	178,02	127,02	190,00
Number of trainees per 100 workers									
Managers and professionals	59,60	66,09	65,10	60,58	58,27	51,33	66,90	58,96	60,23
Technicians and supervisors	59,59	67,51	64,73	60,94	57,62	47,98	69,53	57,18	61,97
Clerks	41,27	45,61	46,67	43,82	37,83	33,89	47,82	39,93	42,56
Skilled blue collars	36,52	41,12	40,47	37,16	35,00	30,57	41,22	34,47	38,83
Unskilled blue collars	36,48	30,82	31,38	26,93	60,63	18,76	49,53	22,11	54,91

Appendix Table A1 (continued)

Hours of training per worker									
Managers and professionals	21,45	23,99	24,54	22,70	19,75	16,85	25,51	21,20	21,69
Technicians and supervisors	19,45	21,85	21,69	19,97	18,69	15,22	23,12	18,35	20,54
Clerks	12,07	14,07	14,09	13,08	10,70	9,29	14,52	11,54	12,58
Skilled blue collars	6,31	7,00	7,11	6,10	6,79	5,19	7,19	5,53	7,18
Unskilled blue collars	6,59	6,72	6,88	6,90	5,61	5,57	7,11	6,24	7,07
Organisational change (dummy variable)	0,36	1,00	0,43	0,40	0,31	0,28	0,44	0,37	0,35
Introduction of computer and digital networks	0,46	0,54	1,00	0,50	0,40	0,36	0,54	0,41	0,50
Indicator for large plant (more than 200 workers)	0,53	0,64	0,63	0,62	0,40	0,00	1,00	0,51	0,54
Indicator for high-density local labor market (above median)	0,51	0,49	0,56	0,42	0,62	0,49	0,52	0,00	1,00
Indicator for service sector	0,42	0,36	0,37	0,00	1,00	0,54	0,33	0,32	0,52
Indicator for multi-establishment firm	0,60	0,67	0,65	0,63	0,56	0,54	0,66	0,59	0,62
Indicator for public sector	0,03	0,03	0,05	0,02	0,05	0,02	0,05	0,03	0,04
Indicator for listed company	0,43	0,52	0,52	0,55	0,27	0,27	0,58	0,41	0,45
Indicator for presence of union delegates	0,77	0,85	0,82	0,84	0,69	0,62	0,91	0,74	0,81
Share of women (%)	35,13	33,96	32,64	25,98	47,53	35,96	34,39	34,30	35,93
Indicator for part-time work (>5% of workforce)	0,37	0,36	0,36	0,22	0,58	0,33	0,41	0,35	0,39
Indicator for delayering	0,41	0,56	0,53	0,51	0,28	0,32	0,49	0,42	0,40
Indicator for just-in-time	0,51	0,54	0,56	0,63	0,34	0,43	0,58	0,57	0,44
Indicator for total quality management	0,67	0,73	0,73	0,82	0,48	0,58	0,76	0,70	0,65
Indicator for computer assisted systems	0,63	0,73	0,74	0,84	0,35	0,47	0,78	0,69	0,58
Indicator for PC use by at least 50% of workers	0,30	0,34	0,47	0,24	0,38	0,25	0,35	0,20	0,40
Number of observations	1114	402	507	641	473	527	587	550	564

Appendix Table A2 - 1
Changes in occupational structure, excess turnover and training with alternative measures of technological change - Personal Computers

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
	A. Overall changes in the occupational structure				
Personal computers	1.25***	0.11	-0.42	-0.95**	0.00
	(0.25)	(0.33)	(0.33)	(0.39)	(0.33)
Number of observations	1114	1114	1114	1114	1114
R-Squared	0.08	0.04	0.05	0.05	0.05
	B. Internal movements				
Personal computers	0.86***	0.30	-0.72**	-0.81**	0.37
	(0.23)	(0.36)	(0.35)	(0.39)	(0.35)
Number of observations	1114	1114	1114	1114	1114
R-Squared	0.07	0.02	0.05	0.05	0.07
	C. External movements				
Personal computers	0.39**	-0.23	0.30	-0.10	-0.35
	(0.18)	(0.23)	(0.22)	(0.26)	(0.22)
Number of observations	1114	1114	1114	1114	1114
R-Squared	0.04	0.05	0.06	0.02	0.03
	D. Excess turnover				
Personal computers	3.83*	4.00	4.58	6.14	-27.40
	(2.12)	(4.34)	(6.56)	(4.32)	(63.74)
Number of observations	1090	1094	1104	1010	790
R-Squared	0.12	0.12	0.13	0.12	0.03
	E. Number of trainees (per 100 workers)				
Personal computers	0.51	6.11*	3.83*	7.17***	-5.69
	(2.23)	(3.69)	(2.08)	(2.34)	(12.34)
Number of observations	1097	1052	1087	892	646
R-Squared	0.13	0.11	0.12	0.10	0.03
	F. Training hours per worker				
Personal computers	1.81*	1.32	1.69**	1.00	-0.17
	(1.06)	(1.01)	(0.85)	(0.83)	(1.17)
Number of observations	1095	1042	1083	888	416
R-Squared	0.14	0.15	0.11	0.06	0.05

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for organisational change. They also include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 sectors.

Appendix Table A2 - 2
Changes in occupational structure, excess turnover and training with alternative measures of technological change – Computer assisted systems

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			A. Overall changes in the occupational structure		
Computer assisted systems	0.26	0.39	-0.13	-0.69*	0.17
	(0.25)	(0.33)	(0.39)	(0.40)	(0.36)
Number of observations	1112	1112	1112	1112	1112
R-Squared	0.06	0.04	0.05	0.05	0.05
			B. Internal movements		
Computer assisted systems	0.02	-0.04	0.03	-0.11	0.09
	(0.26)	(0.35)	(0.40)	(0.45)	(0.40)
Number of observations	1112	1112	1112	1112	1112
R-Squared	0.05	0.02	0.04	0.05	0.07
			C. External movements		
Computer assisted systems	0.21	0.41	-0.13	-0.39	-0.10
	(0.19)	(0.27)	(0.22)	(0.30)	(0.28)
Number of observations	1112	1112	1112	1112	1112
R-Squared	0.03	0.05	0.06	0.02	0.03
			D. Excess turnover		
Computer assisted systems	4.43	-6.78*	-3.52	-22.22***	-27.52
	(4.01)	(3.54)	(8.56)	(6.52)	(87.03)
Number of observations	1088	1092	1102	1008	790
R-Squared	0.12	0.12	0.13	0.14	0.03
			E. Number of trainees (per 100 workers)		
Computer assisted systems	1.34	3.68	2.39	5.48*	-15.13
	(2.66)	(3.20)	(2.39)	(3.20)	(25.21)
Number of observations	1095	1050	1085	892	646
R-Squared	0.14	0.11	0.12	0.10	0.03
			F. Training hours per worker		
Computer assisted systems	2.85**	1.53	0.18	1.68	-1.17
	(1.20)	(1.13)	(0.90)	(1.05)	(1.37)
Number of observations	1093	1040	1081	888	416
R-Squared	0.14	0.15	0.11	0.06	0.05

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for organisational change. They also include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 sectors.

Appendix Table A3 - 1
Changes in occupational structure, excess turnover and training with alternative measures of organisational change – Delayering

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			A. Overall changes in the occupational structure		
Delayering	0.09	-0.09	0.46*	0.15	-0.60*
	(0.21)	(0.28)	(0.26)	(0.35)	(0.32)
Number of observations	1114	1114	1114	1114	1114
R-Squared	0.07	0.04	0.05	0.04	0.06
			B. Internal movements		
Delayering	0.16	-0.54*	0.67**	0.07	-0.37
	(0.21)	(0.28)	(0.28)	(0.36)	(0.33)
Number of observations	1114	1114	1114	1114	1114
R-Squared	0.06	0.02	0.05	0.05	0.07
			C. External movements		
Delayering	-0.06	0.29	-0.12	0.13	-0.24
	(0.16)	(0.20)	(0.19)	(0.26)	(0.26)
Number of observations	1114	1114	1114	1114	1114
R-Squared	0.04	0.05	0.06	0.02	0.03
			D. Excess turnover		
Delayering	-0.44	0.13	4.47	-2.19	-99.25*
	(1.91)	(3.71)	(8.05)	(3.85)	(54.85)
Number of observations	1090	1094	1104	1010	790
R-Squared	0.12	0.12	0.13	0.12	0.03
			E. Number of trainees (per 100 workers)		
Delayering	1.44	-2.59	-1.26	2.91	-4.66
	(2.01)	(3.06)	(1.89)	(2.23)	(16.05)
Number of observations	1097	1052	1087	892	646
R-Squared	0.13	0.10	0.12	0.09	0.03
			F. Training hours per worker		
Delayering	1.00	1.65*	-0.27	1.56*	3.47***
	(0.95)	(0.87)	(0.71)	(0.82)	(1.10)
Number of observations	1095	1042	1083	888	416
R-Squared	0.14	0.15	0.11	0.07	0.07

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for the use of computer and digital networks. They also include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 sectors.

Appendix Table A3 - 2
Changes in occupational structure, excess turnover and training with alternative measures of organisational change – Just-in-time

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			A. Overall changes in the occupational structure		
Just-in-Time	-0.18	0.09	-0.16	0.74**	-0.48
	(0.21)	(0.27)	(0.26)	(0.32)	(0.31)
Number of observations	1100	1100	1100	1100	1100
R-Squared	0.07	0.04	0.06	0.05	0.06
			B. Internal movements		
Just-in-Time	-0.15	0.10	0.21	0.65*	-0.81**
	(0.20)	(0.29)	(0.28)	(0.34)	(0.33)
Number of observations	1100	1100	1100	1100	1100
R-Squared	0.06	0.02	0.04	0.06	0.08
			C. External movements		
Just-in-Time	-0.06	-0.04	-0.29	0.24	0.14
	(0.16)	(0.20)	(0.20)	(0.27)	(0.26)
Number of observations	1100	1100	1100	1100	1100
R-Squared	0.04	0.05	0.06	0.02	0.03
			D. Excess turnover		
Just-in-Time	-2.53	1.45	-1.18	-0.50	-66.42
	(1.86)	(3.38)	(7.84)	(4.21)	(51.10)
Number of observations	1076	1080	1091	996	783
R-Squared	0.12	0.12	0.13	0.13	0.03
			E. Number of trainees (per 100 workers)		
Just-in-Time	2.73	2.90	-1.46	2.54	-6.00
	(2.12)	(3.24)	(1.95)	(2.08)	(6.38)
Number of observations	1083	1038	1073	883	640
R-Squared	0.14	0.10	0.12	0.09	0.03
			F. Training hours per worker		
Just-in-Time	1.90*	2.65***	-0.39	0.81	0.22
	(1.00)	(0.95)	(0.75)	(0.62)	(1.11)
Number of observations	1081	1028	1069	879	414
R-Squared	0.14	0.15	0.12	0.06	0.05

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for the use of computer and digital networks. They also include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 sectors.

Appendix Table A3 - 3
Changes in occupational structure, excess turnover and training with alternative measures of organisational change – Total quality management

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			A. Overall changes in the occupational structure		
Total quality management	0.27	0.33	0.38	-0.48	-0.49
	(0.23)	(0.29)	(0.36)	(0.37)	(0.33)
Number of observations	1112	1112	1112	1112	1112
R-Squared	0.07	0.04	0.05	0.04	0.05
			B. Internal movements		
Total quality management	-0.13	-0.03	0.69*	-0.33	-0.21
	(0.20)	(0.31)	(0.37)	(0.42)	(0.37)
Number of observations	1112	1112	1112	1112	1112
R-Squared	0.06	0.02	0.05	0.05	0.07
			C. External movements		
Total quality management	0.39**	0.26	-0.42*	0.03	-0.27
	(0.18)	(0.24)	(0.24)	(0.28)	(0.28)
Number of observations	1112	1112	1112	1112	1112
R-Squared	0.04	0.05	0.06	0.02	0.03
			D. Excess turnover		
Total quality management	-1.59	-0.76	-21.43**	-11.06**	-188.41**
	(3.79)	(5.88)	(8.91)	(5.19)	(94.30)
Number of observations	1088	1092	1102	1008	789
R-Squared	0.12	0.12	0.14	0.12	0.04
			E. Number of trainees (per 100 workers)		
Total quality management	4.25*	-1.10	1.69	5.86*	-22.12
	(2.41)	(3.94)	(2.10)	(3.34)	(32.12)
Number of observations	1095	1050	1085	890	645
R-Squared	0.13	0.10	0.12	0.10	0.03
			F. Training hours per worker		
Total quality management	1.62	0.49	0.16	0.28	0.89
	(1.08)	(1.12)	(0.79)	(0.89)	(1.32)
Number of observations	1093	1040	1081	886	416
R-Squared	0.14	0.14	0.11	0.06	0.05

Notes:
(1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) Regressions in all panels include controls for the use of computer and digital networks. They also include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 sectors.

Appendix Table A4
Changes in the occupational structure, excess turnover and training according to sector, size, and local labour market density

	Managers and professionals	Technicians and supervisors	Clerks	Skilled blue collars	Unskilled blue collars
			A. Overall change		
Chorga (ref: small, low dens, manuf.)	0.40	-0.44	0.66	0.10	-0.71
	(0.44)	(0.58)	(0.56)	(0.87)	(0.85)
Network (ref: small, low dens, manuf.)	0.62	0.47	-0.75*	-0.95	0.61
	(0.41)	(0.57)	(0.45)	(0.74)	(0.69)
Chorga x high density	0.54	-0.30	0.16	0.30	-0.70
	(0.42)	(0.57)	(0.50)	(0.73)	(0.69)
Network x high density	0.92**	-0.90*	-0.49	1.45**	-0.98*
	(0.36)	(0.52)	(0.48)	(0.64)	(0.59)
Chorga x large plant	-0.23	0.12	-0.36	0.69	-0.21
	(0.47)	(0.61)	(0.66)	(0.80)	(0.74)
Network x large plant	-0.16	-0.62	1.21**	-0.02	-0.42
	(0.42)	(0.57)	(0.54)	(0.68)	(0.63)
Chorga x service sector	-0.41	0.69	-1.70**	-0.44	1.86***
	(0.48)	(0.66)	(0.69)	(0.76)	(0.68)
Network x service sector	-0.14	0.32	-0.15	0.35	-0.37
	(0.42)	(0.60)	(0.60)	(0.68)	(0.62)
			B. Internal movements		
Chorga (ref: small, low dens, manuf.)	0.48	-0.18	0.56	0.32	-1.18
	(0.45)	(0.59)	(0.58)	(0.80)	(0.78)
Network (ref: small, low dens, manuf.)	0.28	0.77	-0.67	-0.93	0.55
	(0.47)	(0.60)	(0.48)	(0.75)	(0.73)
Chorga x high density	0.43	-0.42	-0.07	0.66	-0.61
	(0.37)	(0.59)	(0.55)	(0.71)	(0.68)
Network x high density	0.72**	-0.99*	-0.39	0.95	-0.28
	(0.34)	(0.54)	(0.52)	(0.66)	(0.62)
Chorga x large plant	-0.68	-0.11	0.07	0.24	0.48
	(0.43)	(0.62)	(0.67)	(0.77)	(0.73)
Network x large plant	0.27	-0.74	1.06*	-0.03	-0.56
	(0.42)	(0.59)	(0.57)	(0.71)	(0.67)
Chorga x service sector	-0.13	0.50	-1.42**	-0.33	1.38**
	(0.42)	(0.68)	(0.72)	(0.75)	(0.69)
Network x service sector	-0.45	0.39	-0.01	0.69	-0.62
	(0.41)	(0.62)	(0.65)	(0.71)	(0.66)
			C. External movements		
Chorga (ref: small, low dens, manuf.)	-0.09	-0.39	-0.04	0.02	0.50
	(0.31)	(0.42)	(0.39)	(0.62)	(0.65)
Network (ref: small, low dens, manuf.)	0.34	-0.10	0.04	-0.26	-0.03
	(0.29)	(0.38)	(0.34)	(0.54)	(0.55)
Chorga x high density	0.06	0.11	0.34	-0.36	-0.14
	(0.32)	(0.44)	(0.40)	(0.58)	(0.52)
Network x high density	0.25	0.12	-0.40	0.63	-0.60
	(0.28)	(0.39)	(0.36)	(0.50)	(0.46)
Chorga x large plant	0.42	0.53	-0.29	0.05	-0.71
	(0.34)	(0.47)	(0.41)	(0.61)	(0.56)
Network x large plant	-0.40	-0.09	0.02	0.22	0.24
	(0.31)	(0.42)	(0.38)	(0.53)	(0.50)
Chorga x service sector	-0.10	0.07	-0.38	-0.06	0.47
	(0.35)	(0.52)	(0.46)	(0.67)	(0.54)
Network x service sector	0.20	-0.29	0.16	-0.20	0.13
	(0.31)	(0.45)	(0.44)	(0.54)	(0.50)

Appendix Table A4 (follow)
Changes in the occupational structure, excess turnover and training according to sector, size, and local labour market density

			D. Excess turnover		
Chorga (ref: small, low dens, manuf.)	5.92	11.45	4.31	22.20**	38.83
	(4.13)	(13.17)	(14.37)	(10.78)	(122.36)
Network (ref: small, low dens, manuf.)	-2.34	-10.42	-11.80	-3.54	-141.90
	(4.16)	(7.52)	(13.09)	(8.32)	(163.23)
Chorga x high density	-1.62	-7.81	25.51*	0.79	-72.27
	(5.15)	(14.00)	(13.69)	(9.56)	(76.24)
Network x high density	6.09	13.66	32.47**	21.68**	100.33
	(5.60)	(8.66)	(12.96)	(8.41)	(89.00)
Chorga x large plant	-1.20	-9.96	-14.25	-26.68**	-51.18
	(4.82)	(11.51)	(16.19)	(10.54)	(150.55)
Network x large plant	0.70	8.98	13.37	1.40	202.90
	(4.97)	(7.42)	(15.71)	(9.42)	(182.35)
Chorga x service sector	-9.39	10.90	-31.61	-1.95	-55.38
	(6.57)	(15.45)	(20.75)	(12.73)	(185.13)
Network x service sector	-5.03	-7.76	0.63	-5.92	401.04
	(5.57)	(7.13)	(16.37)	(10.85)	(299.02)
			E. Training		
Chorga (ref: small, low dens, manuf.)	7.82*	10.11**	6.84	-2.07	29.22
	(4.48)	(4.97)	(4.37)	(4.80)	(30.57)
Network (ref: small, low dens, manuf.)	12.89***	1.88	7.39*	-0.81	31.07
	(4.28)	(4.84)	(4.05)	(4.34)	(28.87)
Chorga x high density	-0.18	9.69	-3.08	8.27*	6.62
	(4.12)	(7.52)	(3.80)	(4.64)	(21.07)
Network x high density	-3.17	5.16	-0.18	-1.29	-32.39
	(4.14)	(6.45)	(3.69)	(4.66)	(40.46)
Chorga x large plant	-5.64	-3.29	-5.48	5.81	-41.81
	(4.26)	(5.74)	(4.23)	(5.17)	(45.79)
Network x large plant	-3.57	1.81	-0.82	7.90*	-30.69
	(4.11)	(5.63)	(4.07)	(4.65)	(33.63)
Chorga x service sector	4.36	-12.40*	0.50	-1.00	-86.23
	(4.52)	(6.76)	(4.27)	(8.55)	(73.06)
Network x service sector	-10.73**	-6.43	-4.30	-0.21	-34.70
	(4.44)	(6.39)	(4.50)	(7.09)	(45.81)

Notes:

(1) Robust standard errors in parentheses

(2) *** p<0.01, ** p<0.05, * p<0.1

(3) Regressions in all panels include controls for plant size (dummy variable for plants with more than 200 employees), being located on a high-density labour market, multi-establishment firms, public sector companies, listed companies, presence of union delegates, share of women in the labour force, part-time work (dummy variable for firms with more than 5% of workers being part- time) and 16 sectors.

Data appendix

In this appendix, we detail the key steps taken in preparing the data. The data sources are described in the data section in the text.

We start from a sample of 2894 plants from the REPONSE (1998) survey, with information on technical and organisational changes as well as key firm and plant characteristics. Matching this sample with the DMMO-EMMO, ESE and 24-83 sources yields a sample of 1537 plants.

The relatively low matching rate (53%) is due, in particular, to the fact that the EMMO is not an exhaustive data source (plants are sampled at a rate that depends on their size) and that the 24-83 fiscal forms are not systematically coded.

In order to achieve this matching rate, we extrapolate some of the missing data, using the following procedures:

- when a plant is only present for 1 (resp. 2) of the 3 years in the 24-83 database, we compute the training variables as averages over 1 (resp. 2) years instead of 3;
- when a plant is missing for some trimesters in a given year in the EMMO-DMMO data, we extrapolate the entries and exits in each occupation from the entries and exits observed during the rest of the year; if a plant is missing during one (or two) of the three years, we extrapolate entries and exits from the other years.

Though these extrapolations introduce measurement error in the movement and training variables, this does not bias the estimates as these are dependent variables in the regressions (it might, however, make them less precise). Moreover, we checked that restricting the sample to those plants that have complete DMMO-EMMO information does not significantly alter the results.

We then perform several consistency checks on this 1537 plant sample. First, we check that the total plant size declared in the ESE does not differ too much from the one declared in the DMMO-EMMO sources, at the beginning and at the end of our period (Dec 31, 1995 and Dec 31, 1998). We drop all plants for which the difference is more than 20% (representing at least 10 workers).

Second, we check for outliers in the changes in the occupational structure. We drop plants for which the sum of the absolute changes in the share of the different occupations is more than 60% (representing more than 10 workers).

Again, we checked the robustness of our results to this procedure. We applied stricter consistency criteria (differences smaller than 10% in plant size across sources, and sum of absolute changes below 40%). The results are preserved.

The final sample has 1114 plants.

The data on local labour market density (the number of employed and unemployed workers per square kilometres, computed over 358 local labour markets) comes from the 1990 population census.